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**Response of the Department
of Energy, Mines and Resources
to the
Report of the
Special Committee of the
House of Commons on
Alternative Energy and Oil
Substitution**

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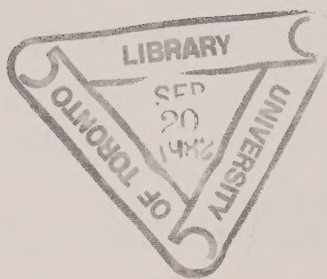


Energy, Mines and
Resources Canada

Énergie, Mines et
Ressources Canada

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of Energy, Mines and Resources
to the
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Alternative Energy and Oil
Substitution**

Canada



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Minister of Energy,
Mines and Resources

Ministre de l'Énergie
des Mines et des Ressources

The Honourable
Marc Lalonde

L'honorable
Marc Lalonde

Ottawa, Canada
K1A 0E4

Dear Mr. Lefebvre:

On May 12, 1981 the Special Committee on Alternative Energy and Oil Substitution tabled its report in the House of Commons. The Report was timely, because it was directly responsive to the first of the precepts that had been set out in the National Energy Program: energy security for Canadians. By thoroughly assessing the entire spectrum of energy alternatives for Canada, the Committee clearly demonstrated that energy security is indeed a realizable objective. Moreover, through the clarity of its recommendations, the Report provided a focal point for a continuing debate regarding directions that future policy action should take.

As you know, a number of critical policy developments have occurred since the Committee's report was released. On September 1, 1981 a five-year energy agreement between the Government of Canada and the Government of Alberta was signed. This was followed by similar agreements with the Government of British Columbia on September 24 and the Government of Saskatchewan on October 26. On March 2, 1982 a historic accord on offshore resource management was reached with the Government of Nova Scotia. Finally, on May 31 of this year, the Government of Canada released The National Energy Program: Update 1982, which summarized progress toward our three objectives, and announced new policies and programs designed to meet the changing circumstances that had arisen since the NEP was introduced in October of 1980.

.../2

Mr. Thomas H. Lefebvre
Chairman of the Special Committee on
Alternative Energy and Oil Substitution
Room 252-WB
House of Commons
Ottawa, Ontario
K1A 0A6

The NEP, and the policy developments that followed it, were naturally concerned with a broader range of issues than those addressed by the Committee. In particular, the NEP had to address a number of questions, relating to pricing and fiscal measures, which were outside of the Committee's terms of reference. At the same time, however, the NEP addressed the specific problem of energy security, and set in motion a number of initiatives designed to shift Canada away from oil to alternative sources of energy. The policy developments over the last year have related directly to a large number of the Committee's concerns, and for the most part, our policy directions have coincided with those recommended by the Committee.

The policy framework now in place as a result of the NEP has necessarily left open a number of the issues raised by the Committee. Indeed, the NEP is not meant to be a one-time statement of comprehensive policy covering all possible policy questions. Rather, it is a dynamic set of evolving responses to a changing world. Nor does the NEP fix Canada's energy supply options. In terms of oil security, the Program has established some strong price and program initiatives to affect a rapid shift off oil to alternatives that are available today in some abundance. Once oil independence has been achieved, Canada will still have a number of difficult energy supply decisions since our conventional energy supplies will be depleting. Your Committee's work has served us well in reviewing this long-term energy perspective. As you have noted, because new and better information regarding non-conventional energy options is continuously coming forward, it is necessary to retain a high degree of flexibility within our basic policy framework. It is only in this way that Canada will be able to find the long term alternatives that are best adapted to changing circumstances.

This program of flexible responses carries with it a requirement for continued dialogue. New ideas must be continuously elicited, assessed, and modified. This is particularly true with respect to areas of new energy technology, where the prospect of continued change and improvement makes the determination of policy direction difficult. It is in this context that I have asked my Department to respond to the Committee's report. I have not asked for, and I am sure that the Committee does not expect, a definitive reply to each of the Report's

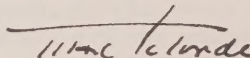
recommendations. This would be to presume that definitive and final views are possible in all areas, and this is simply not the case. My request to the Department, therefore, was to provide a short commentary on the Committee's recommendations in light of the succession of policy developments that have occurred over the last 18 months.

This commentary has now been completed, and I take pleasure in enclosing a copy herewith. I hope it will contribute to the continuing debate on the question of Canada's energy options. To date, the public debate on Canadian energy policy has been dominated by issues relating to the petroleum industry and oil supply. I think this emphasis is misplaced. As the NEP Update showed, the Federal Government attaches great importance to energy conservation, oil substitution, and alternative sources of energy. Indeed, I am convinced that it is primarily through our efforts in these areas that our objective of energy security will ultimately be attained.

I would like to take this opportunity to thank the Committee for the extensive effort that went into the preparation of the Report, and for the significant contribution it has made to the continuing debate regarding Canada's energy future.

With all good wishes and kind regards.

Sincerely,

A handwritten signature in dark ink, appearing to read "Marc Lalonde", with a stylized flourish at the end.

Marc Lalonde

Enclosure



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FOREWORD

The House of Commons Special Committee on Alternative Energy and Oil Substitution was established by the Government of Canada in May of 1980. The seven-member Committee, chaired by T.H. Lefebvre, M.P. (Pontiac-Gatineau-Labelle),* was directed to explore the use of alternative energy sources and technologies to identify those holding particular promise for Canada. The priority was to determine which options would provide the best opportunity for reducing Canada's dependence on oil.

Supported by a staff of scientists and economists, the Committee held hearings in Ottawa and across the country, receiving submissions and testimony from a variety of Canadians. The Committee also met with provincial and territorial representatives and travelled abroad to see alternative energy developments firsthand. The Committee's Report, Energy Alternatives, was released in May 1981, and contained 65 recommendations.

This document provides the Department of Energy, Mines and Resources' commentary on the Committee's report. It reviews the recommendations of the Committee and their relationships to the policies and programs of the Government of Canada. For the most part, there is a close agreement between the Committee's conclusions and the policies already implemented by the Government of Canada. For example, it is estimated that some two-thirds of the federal R&D funding recommendations for energy alternatives for 1981/82 and 1982/83 are consistent with the Lefebvre Committee's own recommendations. Furthermore, under the NEP, Federal R&D expenditures in the area of energy alternatives have more than doubled. Recommendations of the Committee in other areas have already been adopted, in the sense that appropriate departmental programs are now under way or are being planned.**

* Other members were:

Robert A. Corbett, M.P. (Fundy-Royal)
Gary M. Gurbin, M.P. (Bruce-Grey)
A. Allister MacBain, M.P. (Niagara Falls)
Gary F. McCauley, M.P. (Moncton)
Arthur Portelance, M.P. (Gamelin)
Mark W. Rose, M.P. (Mission-Port Moody)

** A list of the Government of Canada's conservation and oil substitution programs can be found in Appendix B.

Some areas of controversy remain, but this, it is hoped, should stimulate further public discussion and promote greater public understanding of the costs and benefits of alternative energy resources. Nevertheless we can be pleased with the progress made in managing Canada's energy demands and reducing national oil consumption over the past year and a half. These factors, coupled with our energy supply initiatives, enhance the probability of attaining our goal of oil self-sufficiency by 1990.

A small number of the Committee's recommendations dealing with proposed institutional changes have not been addressed in the text of the Department's response. It would be more appropriate to refer to them here.

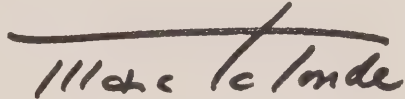
The Committee has recommended that a Ministry of State for Alternative Energy and Conservation be created under the Department of Energy, Mines and Resources, divided into four sections responsible for Conservation, Solar Energy, Methanol and Other Alternatives. It further recommended that the alternative energy corporation, Canertech, and a new Commission known as Hydrogen Canada, report to the new Ministry. Hydrogen Canada would act as the lead agency for hydrogen research, development, demonstration and commercialization in Canada. The Committee also recommended that a review of Hydrogen Canada's progress be conducted within two years of its establishment, after the fourth year of the program and every five years thereafter. The results of the periodic reviews would be tabled in Parliament within three months of their completion or, in the event that Parliament is not in session, would be made public by the Minister.

These proposals, while attractive, are not necessary for the successful reduction in energy demand and the transformation of the economy from oil to alternative energy resources. Nevertheless the Government of Canada has not closed the door to further consideration of the Committee's views on these matters. Amendments to existing legislation recently passed by Parliament would permit the establishment of new Crown Corporations which could be mandated to guide the development of hydrogen or any other energy-related activities.

Furthermore, with respect to the establishment of a new Ministry of State for Alternative Energy and Conservation, we believe that all aspects of energy, whether demand-oriented or supply-oriented, should be managed under one ministry. This arrangement is more likely to achieve a balanced assessment of energy demand and supply

options, and will therefore lead to a more timely and cost-effective realization of the Government's national energy objectives of security, opportunity and fairness.

The Lefebvre Report is a major and significant contribution to energy policy formulation and program development in Canada. I believe the Report and this response will lead to a greater national energy consciousness -- hopefully, to the point where energy conservation and oil substitution become widely accepted as a matter of practical economics.

A handwritten signature in dark ink, reading "Marc Lalonde". The signature is written in a cursive style with a long horizontal stroke above the name.

Marc Lalonde
Minister,
Energy, Mines and Resources Canada

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INTRODUCTION AND SUMMARY

To fulfill its terms of reference, the House of Commons Special Committee acquired a thorough understanding of a wide range of technical, economic and social issues pertaining to a host of alternative energy resources, and an appreciation of the benefits and drawbacks of the existing energy system. The breadth and complexity of the Committee's efforts are indicated by a simple accounting of its deliberations -- more than 30 distinct technologies, 14 fuels and other energy currencies, and 11 resources were examined. The fact that many fuels can be produced in a number of different locations by several technologies using the same or alternative resources compounds the complexity.

The Committee identified seven guiding principles for developing Canada's energy system of the future: energy conservation; the increasing contribution of renewable energy resources; protection of the environment; greater diversity in national energy supplies; an appreciation of the regional differences in energy resource endowments; acknowledgment of strategic concerns; and sensitivity to the social implications associated with any proposed changes.

4*

Many of the above principles are shared by the Department, which agrees with the philosophy that Canada's future energy system should be a mix of hard and soft technologies, combined with a blend of centralized and decentralized sources. Clearly, there are few energy sources and technologies that can be ignored, and environmental disruption must be minimized. Bringing many of the alternatives to commercial status will require judgment and a determination of emphasis and priority. EMR has, over many years, carried out a number of studies concerning various national and regional aspects of economic performance, energy demand and energy supply. The Lefebvre Report complements the Department's work and proves a valuable perspective on how these priorities should be developed.

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Perhaps the most significant and pervasive conclusion argued by the Committee is that dependence on fossil hydrocarbon energy sources, including oil, natural gas and coal, must be eliminated over the long term -- that is, over the next century -- and replaced by sustainable energy sources.

* Refers to the corresponding recommendation number(s) in the Lefebvre Report. The reader should consult Appendix A to find the wording of the Committee's recommendations as well as the location, in this report, of the Department's corresponding response.

Although there is recognition that over the remainder of this century conventional hydrocarbons will be used to a greater extent than today, the Lefebvre Report concludes that this practical reality can be justified only to buy time for a future in which hydrocarbons are entirely eliminated and replaced by an electricity/hydrogen energy system. The Committee has taken the position that energy decisions made today must be considered within the context of this long-term off-hydrocarbon goal. Canada's vast and virtually untapped heavy oil, oil sands and coal resources are considered by the Committee to have social, institutional, economic and environmental implications that are untenable over the longer term.

While this concern for the long-term and ultimate energy system 75 to 100 years ahead is visionary, present realities yield a diverging view of the future, particularly for the role of hydrocarbons in the next century.

Although the appeal of a non hydrocarbon energy system is recognized, realizing this objective will require a number of transitional steps. Ensuring a secure energy future in the next century and energy self-sufficiency in this decade requires all of Canada's vast energy resources -- hydrocarbons, renewables, uranium and conservation.

It was not within the Committee's mandate to explore the full potential of Canada's nonrenewable energy resources. But in looking at energy alternatives, it is important to recognize the opportunities presented by oil and natural gas, coal, hydro and uranium. These resources place Canada in a unique and favoured position among our trading partners. Their potential cannot be ignored, and a rational exploitation of their potential must be analyzed in considering the time frame for a transition to a substantially non hydrocarbon future.

Alternative energy sources and conservation technologies will undoubtedly play an increasingly important role in this century and an even larger role in the next, but hydrocarbons could predominate well into the first half of the next century. This assessment does not deny the validity or desirability of the Committee's non hydrocarbon future. However, such a future is unlikely until well into the next century or beyond -- the exact timing is speculative as it would depend on unpredictable technological advances. Accordingly, the Department is actively supporting new technology and infrastructure requirements for continued development of hydrocarbon resources as it widens its study of alternative energy opportunities.

The Committee's concern for environmental and economic impacts of hydrocarbon development is shared by the Government of Canada. With prudent management, potential impacts can be held within socially acceptable dimensions. Research programs by Energy, Mines and Resources and other federal departments are designed to ensure a full appreciation of environmental implications associated with all energy developments.

In moving off hydrocarbons, the Committee recommends reducing oil consumption as rapidly as possible. This strategy is strongly endorsed by the Government and is a major element of the National Energy Program (NEP).

To move off oil in the various sectors of the economy, the Lefebvre Report states that primary emphasis should be in four distinct areas:

- 1) an intensified effort in energy conservation;
- 2) an expanded activity in most aspects of solar research, demonstration and commercialization;
- 3) an expanded use of methanol, especially for transportation users;
- 4) a transition to an energy system based on hydrogen and electricity.

The Department's response to the Committee's recommendations has been organized to reflect these general considerations. This report consists of four sections -- conservation and oil substitution, alternative transportation fuels, electricity, and hydrogen.

1. Conservation and Oil Substitution

Energy conservation was not explicitly included in the Committee's terms of reference. But as many witnesses stressed the importance of energy efficiency, energy conservation was seen by the Committee as an alternative energy source.

Overall, energy conservation (together with oil substitution) represents the fastest and least expensive approach to Canada's most pressing energy problem - the shortfall of petroleum. Conservation also has a major role in reducing the impact of rising costs of other energy sources. Consequently, the Government is intensifying its energy conservation efforts in all sectors of the economy.

Consistent with the Committee's thinking on energy conservation, the Department supports activities in six broad areas: analyzing energy use patterns and the economics of energy conservation in all sectors of the

economy; educating the public on the merits of energy efficiency in design, construction, and performance; stimulating energy efficiency by providing financial support for various incentive programs; developing energy performance standards; developing standard testing procedures to rate energy efficiency; and enforcing regulations governing the efficiency of energy use.

5

In the area of energy conservation, the Department's initiatives go well beyond the recommendations of the Committee. Industrial energy conservation programs are a case in point. Federal financial support is provided to the Voluntary Industrial Energy Conservation Task Forces and other industrial conservation programs such as the National Energy Audit Program (NEAP), the Atlantic Energy Conservation Investment Program (AECIP), and Accelerated Capital Cost Allowances (Class 34). The Department anticipates an oil equivalent savings in 1990 of about 95,000 cubic metres/day from conservation measures in the industrial sector compared to the continuation of pre-1972 trends.

In the case of energy conservation in buildings, the Canadian Home Insulation Program (CHIP) now extends eligibility for reinsulation grants to almost 80 per cent of Canadian homes. A range of other initiatives such as R&D and demonstration are under way in the area of air-to-air heat exchangers, heat pumps, district heating and the design of super energy-efficient houses.

Oil substitution is also being vigorously pursued. Thus, to encourage homeowners to convert existing oil-based heating systems to alternative fuels, the Canada Oil Substitution Program (COSP) was introduced in 1980. The Forest Industry Renewable Energy Program (FIRE) provides incentives for conversions to renewable fuels and grants have already assisted off-oil conversions in industry that will displace one million cubic metres of oil equivalent per year. Also, as announced in the National Energy Program: Update 1982, grants will soon be available for conversion of oil-fired boilers in the industrial, commercial and private institutional sectors to natural gas. Furthermore, under the recently announced Remote Community Demonstration Program, a number of remote Canadian communities will be given assistance to develop off-oil options tailored to their individual needs.

Energy conservation and oil substitution are major elements of the NEP. Thus by 1990, they are expected to reduce the 1980 level of Canadian oil demands by the equivalent of the production from two and one-half Syncrude-scale oil sands plants.

2. Alternative Transportation Fuels

Canada's transportation sector, like that of most countries, is virtually 100 per cent dependent on oil. Although conservation can probably eliminate growth in final energy demand in this sector over the next 20 years, it is also essential to vigorously develop alternative transportation fuels.

The second section of this report covers this general topic of alternative transportation fuels, focussing primarily on methanol. The potential of methanol is indeed considerable, but other options may prove to be more attractive in the short term. The conditions that would favour the transition to a methanol-based transportation system are under active evaluation. Research and development activities are also under way to remove impediments to the introduction of methanol should it become a preferred fuel for vehicles. Methanol may also be useful as feedstock to the petrochemical industry, as an export commodity, and as a gasoline extender in gasoline/methanol blends. As the Committee rightly noted, propane and compressed natural gas (CNG) are attractive alternative transportation fuels, particularly over the short and medium term. New programs are now in place that promote these two fuels. While the Committee did not support the production of synthetic gasoline as a transportation fuel, the Department believes this option has enough merit to warrant further evaluation before synthetic gasoline is discouraged.

It is recognized that the technology for a hybrid natural gas/biomass methanol plant should be demonstrated as soon as possible. The first step is to improve wood gasification technology to produce a synthesis gas suitable for the manufacture of methanol. Biomass gasification activities are now receiving active Government support.

While methanol production from biomass or biomass spiked with hydrogen (initially derived from natural gas and later from electrolytic hydrogen) may ultimately be the preferred choice, production should be based on the most economically favourable feedstock. It would be premature to exclude natural gas or coal as potential feedstocks. In fact, the existence of substantial reserves of these resources suggests they may be strong candidates for many years to come. While biomass may never become a nationally preferred feedstock for producing methanol, it will undoubtedly contribute in certain regions.

3. Electricity

The third and fourth sections of this Departmental response examine the roles of electricity and hydrogen respectively. Electricity from existing sources and technologies will certainly play an expanding role, and incentive programs, such as COSP, have been established to encourage households to convert to electricity and other non-oil heating sources. Support is being offered for new electrical generation technologies such as fluidized-bed combustion and coal/water mixtures for utility and industrial boilers. The Department is already supporting research, development and demonstration in many other areas of alternative electrical power generation opportunities recommended by the Committee. Nevertheless, it is a valid conclusion that nonconventional sources such as wind, photovoltaics, small-scale hydro etc. are more suited to highly specialized applications than to large-scale base-load generation.

4. Hydrogen

The energy importance of hydrogen may grow quickly. The evidence suggests that the primary role of hydrogen over the foreseeable future will not be as a fuel but in chemical manufacturing and as a vital feedstock in the production of liquid fuels from hydrocarbon resources, particularly oil sands, heavy oil and coal.

Demand for hydrogen in the chemical and petroleum industries is expected to increase by a factor of five by the turn of the century. Electrolytic hydrogen could replace fossil-fuel-derived hydrogen for such purposes by the 1990s. A significant hydrogen production industry can be expected to develop, and the experience gained could be a valuable first step towards the hydrogen economy promoted by the Committee. Significant economic and technical improvements are required before hydrogen could compete with conventional and other alternative fuels.

To investigate production, distribution, storage and utilization aspects of hydrogen, a national hydrogen and electrochemical research and development program has been established by the National Research Council in close collaboration with EMR and other federal departments. This program will be closely linked to expanding research activity in Quebec and Ontario.

Emphasis will be given to advancing the date when electrolytic hydrogen can replace fossil-fuel-derived hydrogen. A full range of technology related to hydrogen production, storage, use (including fuel cells), and batteries will be investigated. Nevertheless, the technological infrastructure required to support the hydrogen economy promoted by the Committee is at a very

early stage of development and currently defies any realistic estimate of availability. Current efforts are at the stage of fundamental R&D, and therefore it is difficult to justify support at the level recommended by the Committee in the near future before the opportunities for success become much clearer. The time frame for introducing hydrogen as a fuel is such that Canada can afford to proceed steadily towards this long-term goal. Current government policies are judged sufficient to promote the development of a hydrogen manufacturing industry appropriate to the long-term objective of a hydrogen-based energy system.

Solar

With respect to the Lefebvre Report's emphasis on solar power, significant opportunities are present in the solar energy field and expanded research is warranted. The Committee believes that primary emphasis should be placed on heat storage techniques. Perhaps efforts should more properly be directed at reducing the cost and improving the reliability of all components of solar heating systems, including collectors, storage and controls.

The Government of Canada is following a program of demonstrations, industrial support and federal procurement to encourage the development of solar energy and a viable solar industry in Canada. While research in all areas is continuing, the evidence suggests that solar space heating is a marginal application compared to the domestic water-heating opportunities at present. Any economic breakthroughs will depend on the results of existing research programs. In the next century, it is possible that the contribution of solar power will be substantially larger, in absolute terms, than today. The opportunity must, however, be weighed in context with other options. The share of solar energy in the total national energy supply is expected to remain small over the next 20 to 30 years.

Clearly, Canada has a broad range of energy opportunities and the Government of Canada is already an active participant in the development of virtually all the technologies, energy currencies and resources evaluated by the Committee.

Government has a valuable role to play in bringing new technologies and fuels to the point of commercial utilization. Several strategies have been developed to fulfill this role -- communicating opportunities to the public; creating a fiscal, financial and technical environment that will encourage and sustain new energy options; and encouraging the private sector to participate in the development of desirable new technologies. The process of commercialization itself requires the participation of federal and provincial governments, the

private sector and the consumer. To be truly commercial, an alternative must meet stringent requirements, including technological readiness, economic justification, institutional and regulatory compliance and market acceptance.

There are a number of ways that the Government of Canada could influence the commercialization process. Instruments of government assistance include: research, development and demonstration funding to promote technological readiness; tax incentives and grants to improve the economics and market acceptance for those alternatives where the private sector appears ready to resolve outstanding technology and infrastructure problems; communications programs to accelerate market acceptance; and venture capital and management assistance where commercialization may proceed in collaboration with the private sector.

1 It is worth noting that even before the NEP was put in place, priority for increased energy R&D expenditures was in the field of energy alternatives -- conservation, renewables and synthetic fuels -- which received about 70 per cent of the increases in energy R&D funding since the OPEC crisis of 1974. Under the NEP, the federal government is planning to almost double its annual energy R&D expenditures (\$171 million in 1981-82, excluding NEP funds) to a total of about \$325 million by 1983-84. For 1982-83, total federal energy R&D expenditures include \$33 million for new liquid fuels, \$33 million for conservation, \$61 million for new energy sources including renewables and \$160 million for conventional energy sources. These activities amount to a commitment of \$287 million.

1

These commitments can be readily demonstrated by several initiatives undertaken since the release of the Lefebvre Report. Notable examples include expanded program funding for energy conservation in buildings and for industrial processes, electrolytic hydrogen production, a demonstration of compressed natural gas, and commercial demonstration programs in the production of methanol and ethanol from cellulosic (wood fibre) feedstocks. In the latter two examples, Canertech -- a new Crown corporation established by the Government of Canada -- has played a major role. This venture capital development company underscores the value of Crown corporations as a government vehicle in energy policy.

The allocation of financial, technical and economic resources to any particular area of energy is, of course, accomplished with special regard to the specific national resource and technology advantages of the country. Within Canada, this suggests a dominant role for hydrocarbons until at least the middle of the next century, combined with a very favourable outlook for numerous alternatives.

The Lefebvre Report offers a valuable independent assessment of alternative energy both in Canada and abroad. The Department is convinced that the Committee's efforts have extended the quality of debate on Canada's energy future and have helped to pave the way for the development of a number of viable alternatives that will reduce the extent of Canada's long-term oil dependency.

CHAPTER ONE
CONSERVATION AND OIL SUBSTITUTION

Planning for energy self-sufficiency has two major thrusts. The first is to encourage the orderly expansion of energy supplies; the second is to encourage the rational use of energy by consumers.

To the extent that energy conservation and oil substitution techniques can displace the need for new energy supplies at lower or equivalent cost, demand restraint will continue to be encouraged as a major part of the NEP. In the planning process the principle followed is that the government will encourage the mix of conservation technologies and energy sources that provides the required services associated with the use of energy, such as space comfort, process heat and mobility, at the lowest cost.

Recognizing the major potential that exists for reducing energy demand at a cost lower than that of expanding supplies, the NEP emphasizes the major role that energy conservation and oil substitution techniques must play in national energy policy. Initiatives have been expanded to encourage residential, industrial and transportation sectors to adopt conservation techniques. New programs also have been initiated to more fully document and transfer new techniques to the private sector through demonstration activities, pilot programs and increased research and development efforts. Initiatives are also being undertaken to increase the dialogue with the private sector in order to identify existing problems more fully and to discuss alternative approaches, including an extension of voluntary conservation efforts.

The Committee's observation that conservation could "offer the best return in managing Canada's energy affairs through the remainder of this century" is laudable. Its view that in many situations it is less costly to implement energy conservation than to expand conventional energy supplies is endorsed. Furthermore, conservation technologies can often be deployed more rapidly than supply technologies with much less impact on the environment. However, the attainment of the maximum economic potential from conservation requires greater resources than those available to the Government of Canada alone. A commitment is needed from all levels of government, energy companies and utilities, the general private sector and individuals.

Buildings Sector

Buildings -- from single detached houses to apartments to offices and hospitals -- account for approximately 35 per cent of final energy demand in Canada and the potential for the economic reduction in energy use is probably greater than in any other sector. Thus, from a 1973 base, the conservation potential for space heating in existing buildings is estimated to average about 50 per cent, while in new buildings the potential is in the range of 70 to 85 per cent.*

To best achieve better conservation in the buildings sector the Committee implied that governments should be active in four broad areas.

6 & 59

1. Educating the building trades and the public at large on the merits and procedures for achieving energy efficiency in design and construction (including home retrofit).

In conjunction with the building industry, the Department is currently implementing the Super Energy-Efficient Housing Demonstration Program (SEE) to design and build a number of super energy-efficient houses across Canada.

In addition, in cooperation with other federal departments, considerable efforts have been made to ensure that architects, builders and contractors practice energy-efficient design and construction. The Department has financially supported workshops for builders, a handbook for architects on energy-efficient design, and sponsored the Low Energy Building Design Awards competition (LEBDA), which was concluded in 1981.

A new program to accelerate the use of energy-efficient technology in all Canadian buildings -- the Building Technology Support Program (BTSP) -- has been initiated by the Department. Funding is currently being provided to a number of research organizations and firms across Canada. This funding is being used to identify those technologies that would have the most economically attractive energy contribution, to establish priorities for research, development, demonstration and transfer activities, and to hasten the early adoption of effective low-energy building techniques. Another important buildings program is the Home Energy Advisory Service (Ener\$ave) which was created to provide the public with a computerized home energy analysis and a telephone advisory service.

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* Based on market prices expected over the next five years at investment paybacks of less than six years.

In addition to communicating energy conservation opportunities to the private sector through publications and demonstrations, the Federal Government has initiated the Canadian Home Insulation Program (CHIP) which provides taxable grants of up to \$500 to accelerate the retrofit (insulation, weatherstripping and caulking) of Canadian residences. A recent change of the eligibility date in most provinces -- from January 1, 1961 to January 1, 1971 -- extends CHIP eligibility to almost 80 per cent of Canadian homes. Today, more than 1.3 million homes have been insulated under CHIP.

2. Developing prescriptive and performance energy standards for new buildings.

For some time the Department has promoted the development of prescriptive energy standards for new buildings. These specify the minimum thermal performance (for example, insulation levels) requirements of the building and certain energy-related requirements for lighting and mechanical equipment. A model energy code, The Measures for Energy Conservation in New Buildings, was produced by the Associate Committee on the National Building Code in 1978; under the NEP this has been adopted for all houses funded or insured under the National Housing Act (NHA). The "Measures" should result in a reduction in heating energy requirements of about 30 per cent from the Canada Mortgage and Housing Corporation's (CMHC) 1975 standards. Further revisions are now being contemplated for this standard. If adopted, these revisions would result in further savings of about 10 per cent. This overall 40 per cent saving compares to the economically justified potential of about 75 per cent that has been proven in individual houses and small-scale federal-provincial demonstrations.

8 Energy performance standards -- which set maximum energy use levels for buildings without specifying how to achieve these levels -- are in their early stages of development. When they are developed consideration will be given to incorporating them into the National Building Code. However, energy codes alone cannot ensure that new buildings are energy efficient since, for example, circumstances change more quickly than standards can be revised. The SEE program, an element of the NEP, is based on energy performance standards and should make an important contribution to the use of performance indicators in constructing new Canadian residences. Performance criteria for super energy-efficient housing will result in energy savings of about 75 per cent as compared with the 1975 standards.

8 An effective strategy to significantly improve the energy efficiency of new houses must go considerably beyond codes and include training, information transfer, demonstrations and other activities, such as the education of mortgage lenders, in order to increase the industry's capability to provide efficient new units, and to increase the public's desire and ability to purchase them. Each of these strategy elements is being addressed by current federal initiatives.

3. Developing universal testing procedures to rate the energy efficiency of buildings.

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The Committee urged the federal government to establish standard procedures for testing the energy performance of buildings including airtightness, and to apply these procedures to federal buildings and to all new CMHC financed homes.

The Department endorses this recommendation and is currently funding the development of airtightness test procedures and standards and, through the Canadian Standards Association, energy "labels" that would indicate the energy performance of housing units.

Guidelines and standards for government buildings developed by the Canadian Intergovernmental Energy Management Committee were adopted in September 1981. Included among the standards were those relating to Building Energy Performance Indicators (BEPI's).

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4. Enforcing regulations governing the efficiency of energy use.

As a part of the NEP, CMHC is now enforcing the existing minimum standards for all housing constructed under the provisions of the National Housing Act. More widespread enforcement would require full cooperation of provincial and municipal governments. But, as the Committee noted, adequate numbers of building inspectors are not available, and this is a problem that is being addressed through federal-provincial discussion. A related problem is that well-designed buildings can have high energy consumption if they are poorly built. Accordingly, inspections may be more useful after the building is completed, rather than before or during construction, and therefore new approaches to enforcement of standards are being examined. The CSA labelling program and tests planned during the SEE program should reveal some options to addressing this problem.

The Government of Canada's Energuide program for the energy consumption labelling of major household appliances has been designed to stimulate improvement in energy efficiency. Through improved consumer awareness, manufacturers are being motivated to accelerate and extend the introduction of appliance conservation technologies.

7 The Committee favoured using federally owned or financed buildings to demonstrate the benefits of certain energy conservation measures. The Department supports this position and through a variety of initiatives is encouraging the upgrading of its own facilities and the construction of super energy-efficient buildings.

6 & 59 The Lefebvre Report emphasized the need to consider the increased use of passive solar techniques in Canadian buildings. Passive solar energy can undoubtedly contribute to the construction of energy-efficient, cost-effective buildings. However, a focus on passive solar techniques in isolation from other measures -- insulation, airtightness, proper selection of heating systems, care in construction -- can result in a higher total cost for a given reduction in space-heating energy requirements. The Department's programs are structured to emphasize the need for optimal integration of all low-energy building techniques.

12 Underground construction is one building technology that received some attention from the Committee. The Department agrees that in appropriate circumstances it may be a cost-effective conservation technology. However, overall costs of this approach have tended to be relatively high, and consumers and businesses have generally not preferred this type of living or working environment. The Department is supporting analysis and demonstration of this type of construction to obtain a better idea of its potential contribution to energy conservation goals.

11 The Government of Canada is also working with industry, the Canadian Electrical Association and the Canadian Standards Association to improve all aspects of energy efficiency in lighting. Lighting efficiency is an important element of federal conservation R&D programs and of the Federal Internal Energy Conservation Program, designed to hold down overall energy consumption by federal departments, agencies and Crown corporations.

36 & 37 As the Committee indicated, the use of heat pumps to increase the utilization of low-grade energy sources has attracted renewed attention in Canada. Approaches to the recovery of energy from low-grade waste heat streams include the use of heat exchangers, as well as heat pumps

in residences, commercial buildings, and industrial processes. Opportunities for the use of heat pumps and other heat-recovery systems are particularly significant in the industrial sector due to the high volume and temperature of waste heat streams.

In Canada it is particularly important that heat pumps for space heating work as efficiently as possible at low temperatures. The Government of Canada has financially supported the Canadian Electrical Association heat pump project referred to in the Committee's report. This project has produced a prototype cold-weather heat pump that is now nearing commercialization.

While the Lefebvre Report recommends that the use of heat pumps should be encouraged in community recreation complexes, not all such complexes are suited to this application. Several federally supported heat-pump demonstrations are already under way, including some in community recreation complexes. In each case performance is being monitored in order to provide better direction for future applications of heat pump technology.

The potential for heat pumps in a range of applications is very large, and offers a near-term commercial opportunity that is now being exploited by the private sector. These opportunities include the use of heat pumps for the production of hot water and process heat as well as for the provision of space heating and cooling requirements.

In recognition of these opportunities, the federal government sponsored a seminar on heat pumps in 1981 and a major national conference on the subject in 1982.

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District heating was also considered by the Committee as an energy-conserving technology best suited for new subdivisions, communities and industrial parks. Clearly, district heating is a serious option in high-density commercial areas, new resource towns and other remote communities. The costs and benefits of such systems, however, must be compared to other options including energy conservation technologies within buildings. New energy-efficient commercial buildings, for example, require no heat from external sources, and super energy-efficient housing will probably be a more attractive option to reducing space heating costs than district heating.

Currently, the Department is evaluating the potential for district heating for small communities that depend on oil but have access to other fuels: wood wastes, municipal wastes or industrial coal.

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35 Geothermal energy may become economical in certain regions for space heating and other purposes. The rate at which this resource can be brought on stream depends on advances in extraction technology, and the Department concurs with the Committee's conclusion that geothermal energy will not add significantly to Canada's energy supply in this century. Currently there is an ongoing R&D effort in geothermal energy which has led to demonstration projects in British Columbia and Saskatchewan. Under EMR's geothermal program for 1982-83, approximately \$785,000 is devoted to defining the potential of this resource and to developing technologies for geothermal exploration, 35 assessment, extraction and application systems.

Industrial Sector

Industry consumes more energy than any other sector of the economy, accounting for approximately 40 per cent of final energy demand.

From 1972 to 1980, Canadian industry reduced the amount of energy required to produce a unit of output by 15 per cent, mainly through the use of low cost measures and by substituting industrial by-products such as wood wastes for primary energy sources. The resulting reduction in industrial energy demand in 1980 was equivalent to 80 million cubic metres of oil per year, as compared to the continuation of pre-1972 efficiency trends.

Current estimates suggest that energy efficiency could be improved by a further 15 to 20 per cent by 1990 as a result of the continued use of low capital-cost measures together with higher cost retrofitting of existing facilities and the installation of new processes. Technological innovations and/or accelerated energy price increases could lead to further improvements.

The Department is encouraging a high degree of energy efficiency in manufacturing and processing by supporting a number of initiatives:

- (a) the Voluntary Industrial Energy Conservation Task Forces, a network of 16 industry groups that exchange information on energy conservation opportunities and techniques, set and report on targets for improvements in energy efficiency, and serve as a focal point for government-industry discussions;
- (b) the National Energy Audit Program (NEAP), which helps industrial and commercial establishments identify areas of energy waste, and plan and implement corrective action;

- (c) the Atlantic Energy Conservation Investment Program (AECIP) which provides grants to industrial establishments and private institutions in Atlantic Canada to finance a portion of their energy conservation investments;
- (d) the Accelerated Capital Cost Allowance (Class 34) Program, which provides a two or three-year write-off for eligible systems, equipment and facilities designed to increase energy efficiency, reduce oil consumption or use renewable energy resources.

31 Industrial energy conservation did not attract great attention in the Lefebvre Report. However, the Report acknowledges that by coordinating industrial processes, either within the same plant or among adjacent facilities, energy cascading systems can be designed. Here the waste energy from one industrial operation becomes the energy source for the next. Energy thus can be transferred and reused until it falls to such a low quality level that it cannot be further utilized.

31 The Committee has recognized the potential benefits of this approach, in particular the opportunities offered by industrial co-generation, and favours a more widespread use of this technology. The Department agrees, and has modified the FIRE program so that co-generation facilities are now eligible for funding.

Transportation Sector

The transportation sector consumes a large share of petroleum -- about 56 per cent of refined products, excluding petrochemical feedstocks, in 1981. The achievement of oil self-sufficiency targets will depend to a large extent on the degree of conservation and substitution in this sector. Principal opportunities for petroleum savings are:

- less energy use by automobiles, trucks, and other transport modes through improved combustion, transmissions, aerodynamics, vehicle weight reduction and improved operating procedures such as driving habits and maintenance schedules;
- substitution of alternative fuels for petroleum in road vehicles.

Automobile fuel consumption standards and rising oil prices have already had a major impact on gasoline consumption which in 1981 declined for the first time since World War II. Even with a significant increase in travel and trucking, there is likely to be very little growth in road fuel consumption over the next twenty years.

The Government of Canada and the Canadian motor vehicle industry have developed a program of voluntary fuel consumption standards for new vehicles sold in Canada through to 1985. Legislation has been introduced in Parliament to formalize this program and extend it beyond 1985. The present standards require that the tested fuel consumption of new cars be improved from 11.75 L/100 km* in 1980 to 8.5 L/100 km by 1985. Current trends indicate that the 1985 standard will be exceeded and work is presently being focussed on improving on-road fuel economy under Canadian driving conditions.

Other conservation programs initiated by the Department include demonstrations of ride-sharing -- such as vanpooling -- driver education programs, and a voluntary truck fuel conservation program.

The major federal programs that are in place are:

- Vehicle Fuel Consumption Standards Program
- Ridesharing Program
- Truck Outreach Program
- Conservation R&D Program
- Demonstrations of specific technologies (traffic control, vehicle maintenance).

Oil Substitution - Residential Sector

Canada's 8.5 million housing units account for approximately 20 per cent of final energy demand. Of this demand about 35 per cent is oil, used mainly for space heating.

The Canada Oil Substitution Program (COSP), introduced in the NEP, helps homeowners convert from oil to natural gas, electricity, propane, coal, peat and renewables (wood and solar). In some parts of the country, conservation measures are also eligible under COSP due to the lack of reasonably priced alternative fuels. Under COSP, a taxable grant covers half of the eligible costs of materials and labour to a maximum of \$800 for a single residence and to \$5,500 for a multiple unit building. Already more than 200,000 households have taken advantage of this program, resulting in annual savings of more than 1 million cubic metres of oil.

* Litres/100 kilometres

Wood Energy Systems

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The increasing use of wood for space heating in urban residential areas was noted by the Committee, and its Report stresses the environmental and safety consequences associated with wood conversion. The Department shares these concerns and is studying the issues of widespread use of wood in both urban and rural areas.

Undoubtedly, fire safety regulations should be reviewed and strengthened. This enforcement is primarily a provincial and municipal responsibility and the Government of Canada has urged the provinces to act. In conjunction with the off-oil incentives for the installation of wood-burning appliances, EMR is funding the development of safety standards for appliances, and guidelines to facilitate the training of inspectors and installers.

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A total of \$450,000 will be spent in 1982/83 to study the safety, efficiency, and environmental aspects of wood-fired appliances.

Solar Systems

Active solar systems have not enjoyed widespread acceptance because of the relatively low cost of conventional fuels compared to high capital costs for solar installations, as well as the lack of standards and technology for chemical and large-scale thermal heat-storage systems. The Committee addressed these concerns, especially the heat-storage problem.

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It would seem prudent to direct efforts not only at the heat-storage question, but also at reducing the cost and improving the reliability of all components of solar heating systems, including collectors and controls. Explicit goals for achieving cost-effective solar heating systems have been developed by EMR, and attempts to achieve these targets are being undertaken by the National Research Council.

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As part of its solar program, the NRC will continue to support thermal heat-storage R&D. The short-term requirement is for small-scale units that will help electrical utilities reduce peak demand for better exploitation of off-peak capacity. Subterranean waters are being explored as heat sources and sinks for large-scale thermal storage. Such sources are widely available, although site-specific.

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Recent experience indicates that simpler solar systems are more economical and practical -- systems that use captured solar heat as it is available, without the need for large storage units, many collectors, or complex controls.

The Government of Canada sustains a program of demonstrations, industrial support and federal procurement to encourage the development of solar energy and a viable solar industry in Canada.

63 EMR has initiated a Solar Domestic Water Heating
Demonstration Program under which about 800 residential
solar water-heating systems will be installed in about a
dozen communities. The commercially available units all
use water as a thermal storage medium. Homeowners and
63 industry will both benefit from the information and
experience obtained from these demonstrations.

Federal facilities are being used as a first market for
solar energy systems to test unproven equipment.
Nevertheless, private market development should be
pursued; incentives are now available in the form of a
three-year tax write-off, as well as consumer grants for
62 certain end users, under the Canada Oil Substitution
Program. Standards are being developed by the Canadian
Standards Association, and warranties by the Canadian
62 Solar Industry Association.

Currently, active solar space heating appears much less
economical than solar domestic water heating and
commercial/industrial process heat because of the storage
problem. Space heating therefore might be better
addressed through alternative routes such as conservation
and passive solar techniques. Breakthroughs in storage
technologies could, however, affect the system's economic
performance. Given this R&D challenge it would be
premature to proceed with a large demonstration program
for active solar space heating systems. The PUSH Program
nonetheless is carrying out a limited number of space
heating projects to gain experience.

Oil Substitution - Industrial, Agricultural and Commercial Sectors

The Forest Industry Renewable Energy Program (FIRE)
initially provided incentive grants to the forest
industries to utilize woodwaste as a source of fuel.
Under the NEP this program has been expanded to other
sectors, to include the conversion of existing facilities
or installation of new facilities using abundant Canadian
resources such as wood residue, municipal waste,
agricultural waste, peat or other biomass instead of
nonrenewable fossil fuels. More than half the funded
projects have been for the purpose of oil substitution --
the target of the program is to save the equivalent of
6 million cubic metres of oil per year by 1986. Already
almost 100 projects across the country have been funded,
representing an annual saving of more than one million
cubic metres of oil equivalent.

The Lefebvre Report recognized that Canada's wood energy resources should be more fully exploited and has recommended the encouragement of a wood densification industry to improve the use of wood biomass primarily for industrial applications, and to a lesser extent for residential and commercial uses.

- 21 The Department agrees that the densification of biomass fuel improves its economy by significantly reducing handling and transportation costs. R&D projects to improve storage properties by developing a water-resistant fuel have been supported under the Energy from the Forest (ENFOR) program. EMR is also supporting the demonstration and commercialization of biomass
- 21 densification systems capable of utilizing this fuel.
- 20 Biogas -- produced by anaerobic digestion of biomass -- was mentioned in the Lefebvre Report as an energy source that can substitute for petroleum on farms and in feedlots and stockyards. The Department recognizes both the energy and environmental benefits associated with this use of waste biomass, and is supporting research on biomass digestion. Demonstration projects are currently under way in Ontario and Nova Scotia, and others are being considered for funding under the Federal/Provincial
- 20 Conservation and Renewable Energy Demonstration Agreements.
- 27 EMR is also assessing the prospects for commercialization of fluidized-bed combustion (FBC) -- a technology that would allow coal, wood and other feedstocks to be burnt with greatly reduced environmental impact. The Department is supporting the construction of a \$13.1-million FBC heating plant at the Armed Forces Base at Summerside, PEI, which is to go into service in 1983 burning high sulphur Nova Scotia coal. Co-firing of the plant with 20 per cent
- 27 wood (heat input basis) will also be demonstrated.

To hasten the penetration of natural gas into markets where conversions from oil have been relatively low, the Government of Canada announced in the National Energy Program Update its intention of meeting 50 per cent of the cost of conversion to natural gas for commercial and industrial facilities that currently use residual oil and do not have dual firing capacity. Specific program criteria are now under development.

Oil Substitution-Electrical Generation

The generation of electric power in Canada currently represents about 3.5 per cent of national oil consumption. In the Atlantic Provinces, where oil represents the major fuel for electric power generation, coal offers an alternative using existing plants.

28 EMR agrees with the Lefebvre Report that coal emulsions -- coal/oil/water and coal/water mixtures -- are an important near-term alternative to oil. With the rapid advent of coal/water technology, in which no oil is required, a major demonstration program has been negotiated between the Department and the Cape Breton Development Corporation and the New Brunswick Electric Power Commission. The program will involve the construction of a pilot facility in Sydney to produce the new fluid fuel, and combustion trials in specially selected furnaces at Chatham, New Brunswick. A related factor has been the agreement between the Cape Breton Development Corporation and Carbogel AB, a Swedish Company considered to be the most advanced developer of coal/water fuels, which contains provisions for technology development in Canada.

27 Fluidized-bed combustion can also substitute coal and other fuels for oil in electrical generation. As the Committee noted, the advantages of this system over conventional boiler technologies include: a reduction in sulphur dioxide and other emissions, a better heat transfer characteristic, compactness and a wider range of fuel possibilities. Moreover, the capital cost of an FBC unit is competitive with conventional solid-fuel boilers.

A total of \$150 million has been allocated under the Special Atlantic Initiatives of the NEP to introduce new coal utilization technologies to the Atlantic Provinces where increased use of indigenous coal can directly substitute for imported oil. Under this program special emphasis is being placed on the introduction of FBC technology. In cooperation with Nova Scotia Power Corporation, utility-scale application of this technology is being evaluated through an assessment of major risk areas. A special facility to assess the materials requirements for utility-scale units is planned for Point Tupper, Nova Scotia with construction scheduled to begin this year.

27 In addition to these activities EMR has already played an important role in analyzing and supporting various FBC technologies. For example, B.C. Power Authority's Hydro study of pressurized FBC technology was cost-shared through the Department's Coal Conversion Program administered by CANMET. Analysis of recirculating fluidized beds is now in progress and construction of a test combustor is under consideration.

35 Also, in British Columbia, the Canada-B.C. Conservation and Renewable Energy Demonstration Program has been supporting (\$325,000 in 1981-82) BC Hydro's geothermal drilling program at Meager Mountain north of Vancouver, where a geothermal-electric site may prove commercially viable. A generating station could be in operation there before the end of the 1980s.

CHAPTER TWO
ALTERNATIVE TRANSPORTATION FUELS

The transportation sector consumes about 45 per cent of all petroleum used in the country. This proportion is expected to increase over the next decade, and reducing consumption will require a great effort on the part of governments, industry and consumers. Improvements in vehicle fuel efficiency and greater use of alternative liquid fuels such as propane, compressed natural gas (CNG) and alcohols can contribute substantially to a reduction in petroleum demand in the short to medium term, but gasoline and diesel fuels will continue to dominate the transportation marketplace in the foreseeable future.

In the long term, transportation systems can become much more energy efficient in a cost-effective way. It is possible that hydrocarbons could be entirely displaced, with hydrogen becoming the dominant vehicle fuel, but no one can accurately predict when this situation might occur. The Department agrees that hydrogen has some attractions as a vehicle fuel, but its widespread use depends on solving a number of economic and technical problems, the most important of which are on-board hydrogen storage and the production of hydrogen by the electrolysis of water. These issues are discussed in the section on hydrogen.

Methanol

- 18 Methanol may be a desirable liquid-fuel alternative for the late 1980s or early 1990s, since it can be produced from a variety of plentiful feedstocks such as coal, peat and biomass. For these reasons the Committee supported the widespread use of methanol. Of the feedstocks, biomass alone or biomass spiked initially with natural gas-derived hydrogen and later with electrolytic hydrogen, 18 was the preferred choice of the Committee.

The Committee supported the widespread use of methanol, but the long-term future for this alcohol fuel depends to some extent on the successful development of improved techniques for biomass gasification. In the short term, the development of a transportation market for methanol could be based on a natural gas feedstock with biomass making important contributions in some regions.

- 17 In support of this fuel option both the Department and the Committee feel that the technology for a hybrid natural gas/biomass methanol plant should be demonstrated as soon as possible. The first step would be the improvement of 17 wood gasification technology for production of a synthesis gas suitable for the manufacture of methanol.

24 Biomass gasification activities have, in fact, received a high priority under existing federal R&D programs such as that on New Liquid Fuels, established under the NEP to promote the development of alternatives to gasoline. A large portion of the recent Energy from the Forest (ENFOR) conversion program is also devoted to gasification and related studies.

24 A novel air type of gasifier that makes a fuel gas from wood has been operated successfully near Hearst, Ontario, and a modification of this technology -- involving gasification with oxygen to produce a suitable gas for synthesis purposes -- is under consideration.

25 & 26 Wood gasification technology could also be applied to the gasification of peat, broadening even further the resource base for the production of gaseous and liquid fuels. The Department agrees with the Committee's recommendation that R&D on peat should include development of gasification technology. Considerable resources for this purpose are now allocated to the NRC through the Office of Energy Research and Development.

25 & 26 At present, the mining, harvesting, dewatering and transporting of peat is not economical in most areas in Canada. But the country is rich in this resource and so a substantial R&D effort on peat technology under Canadian conditions is now under way. Also, to further delineate the resource base, EMR has commissioned studies concerning the inventory and mining of peat in Canada.

Large-scale production of methanol in Canada, however, will have to be based on the most economical feedstocks. Natural gas or coal, for example, may in many cases be less costly and may be preferable in areas where the environment can be protected by pollution abatement controls and by using relatively clean feedstocks. In the United States, coal may become the preferred feedstock for methanol production -- a position the Committee rejects for Canada.

29 Coal Liquefaction

The Committee's position on coal liquefaction is somewhat ambiguous. Since it is a hydrocarbon-based technology, coal liquefaction is not recommended by the Committee as an acceptable option over the long term. It is, however, acknowledged that over the short term a limited number of coal liquefaction projects aimed primarily at export markets could be acceptable, but only with stringent environmental safeguards. It is argued that these plants would earn foreign exchange, generate skilled employment and technological expertise, and provide a supplementary source of synthetic fuel for domestic use in an emergency. But if these projects are economically and

technically viable within acceptable environmental limits, there would be few reasons not to consider them as a source of domestic fuel as well.

EMR believes it is premature to rule out coal liquefaction as a liquid fuel option for Canada. The cost of production for coal liquids is not yet clearly known and the state of the technology is still evolving. It would appear prudent to place Canada in a position where coal liquefaction could be developed as a major commercial liquid fuel supply option should it be required.

The Government of Canada has offered to entertain proposals for foreign investment in Canadian coal liquefaction plants, provided significant benefit to Canada can be shown. Expressions of interest have been received. Also, a number of Canadian consortia are currently investigating the feasibility of coal liquefaction in British Columbia, Alberta, Saskatchewan and Nova Scotia.

It is evident that international developments in the field of coal liquefaction must be monitored closely. Such technical studies must also include a knowledge of environmental effects and the means by which they can be minimized.

An ongoing federal R&D effort at a yearly level of about \$2.0 million was expanded by \$4.4 million under the NEP during 1981/82 to provide Canada with an independent technical assessment of coal liquefaction processes, resource potential and environmental implications. In particular, Canada has an unparalleled opportunity to treat coal blended with bitumen and heavy oil from major resources in Alberta and Saskatchewan, and CANMET, EMR's R&D branch, is currently developing a new 'co-processing' technology.

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Synthetic Gasoline

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Another fuel option the Committee did not support is the production of synthetic gasoline from natural gas feedstock, since natural gas is a finite energy source. Further, methanol is a likely intermediate product in the production of synthetic gasoline -- and possibly diesel fuel in the future -- and it is potentially environmentally preferable to gasoline. There is also a cost and energy penalty in proceeding from methanol to synthetic gasoline. The Committee therefore suggests that methanol itself might be a better end product.

But two factors merit more consideration before synthetic gasoline is discounted as a major option for Canada. First, if methanol itself were to be only an intermediate fuel en route to widespread use of pure hydrogen, then the

high cost of establishing a short-term infrastructure to deliver and use methanol must be weighed carefully against the economic and environmental costs of producing a synthetic gasoline that is entirely compatible with the present system.

Second, gasoline has a significantly higher energy content per unit volume than methanol. It may become economical to convert remote or unconnected natural gas supplies to synthetic gasoline to get these energy sources to market. The reduced shipping cost of gasoline over methanol and CNG, and possibly pipeline gas from the far north, may make synthetic gasoline production advantageous.

The true significance of these factors -- to the economy, to the environment and to the country's overall energy supplies -- must be evaluated thoroughly before methanol-to-gasoline is ruled out as an option for Canada. EMR is currently examining these factors.

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This does not mean that Canada should de-emphasize methanol production. In fact Canada could advantageously expand its production capability over the coming decade, and could possibly become a major world producer. In the short term, however, methanol might have more value as a chemical feedstock or export commodity in a growing world market than as a fuel. Methanol also might be used as a gasoline extender, especially as processes are becoming available to produce the necessary 'co-solvent' along with the methanol in one step. Methanol can also be used in the manufacture of such products as methyl tertiary-butyl ether (MTBE), a valuable blending component with the potential to displace about 10 per cent of gasoline. It can also serve as a medium for the transportation of coal in slurry form through pipelines -- an option now being studied by the Province of Alberta.

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The growing worldwide demand for alcohol fuels has generated corresponding interest in multi-fuel and alcohol engines. Because of the large potential for methanol production in Canada the opportunity may exist for the development of a domestic alcohol engine industry. But it would be premature to provide major encouragement to such an industry until the role for methanol as a dedicated fuel, in Canada, is better identified.

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The Lefebvre Report also recommended that Canada should allow fuel methanol to be sold more cheaply than gasoline to make it attractive as an alternative transportation fuel; but the Department believes it should not intervene on this issue.

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Ethanol

14, 16 & 49 In contrast to the methanol situation, exploitable ethanol feedstock resources could not provide enough ethanol to power the whole transportation sector unless Canada's extensive cellulose resources, primarily wood, were used for this purpose. Until the necessary technology is developed for this, ethanol should be used only as a gasoline extender and not as a substitute transportation fuel in pure form, except perhaps on farms. The Department is concerned however that proper standards and specifications be developed for the formulation and combustion of gasohol.

13 EMR recognizes that there are opportunities to expand ethanol production from several sources other than spoiled agricultural crops. For example, there may be more potential and better economic opportunities for ethanol production from pulp and paper processing wastes. One pulp mill is already producing more than 4 million litres per year from waste pulp liquor. Cellulose may become a preferred feedstock in future, given the potential for technological advances in the cellulose-to-ethanol conversion processes.

EMR shares the Committee's view that federal support for R&D in this area should be forthcoming. The Department has increased its R&D funding for this option under the New Liquid Fuels R&D program established under the NEP.

13 Canertech will be the lead agency in the development of a pilot plant and related R&D programs that will demonstrate new processes to extract ethanol from vegetation, mainly trees. The Government of Canada has earmarked \$5 million over a three-year period to develop this pilot-plant project.

15 A new opportunity for small-scale production of alcohol fuels has been created by recent amendments to the Excise Act which authorize the Minister of Revenue to issue special one-year temporary permits at a nominal fee for experimental, noncommercial fuel alcohol production. Excise duties are dropped for alcohol produced under the special permits, as are many regulations defining its distillation.

Propane

45 Propane is an excellent vehicle fuel that can be readily adapted to existing gasoline engines at a cost of between \$1,200 and \$1,500. Some major car manufacturers are now offering vehicles with factory-installed propane engines for an extra cost of around \$1,000.

The Committee has correctly identified some of the attractive features of propane fuel -- greater combustion efficiency, lower maintenance costs and longer engine life. Since the retail distribution network is now somewhat limited the Committee recommended that the most appropriate use of propane fuel would be for fleet use where vehicles can be centrally fueled. In many regions, the payback period for conversion is relatively short, varying on the extent of vehicle use.

In many countries propane has already gained widespread endorsement as a fleet vehicle fuel; in Canada relatively few fleet operators have considered this option. The Government of Canada has undertaken a number of initiatives to increase the acceptance of propane. The Propane Vehicle Grant Program offers taxable grants of up to \$400 to convert commercial and farm vehicles or to help purchase new propane-powered vehicles. Under the Federal Propane Vehicle Program at least 8,000 federal vehicles will operate on propane by 1985. This commitment will demonstrate the benefits of propane fuel.

For the foreseeable future, the domestic supply of liquids from natural gas is sufficient to justify promoting propane conversions now in order to displace imported oil. At present, about half of Canada's propane production is sold abroad; these exports could be diverted to serve domestic transportation markets.

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Compressed Natural Gas

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Compressed Natural Gas (CNG) can also reduce Canada's dependence on gasoline and diesel fuel. Storage tanks are heavier and bulkier than propane tanks and the vehicle range is more limited. Conversion costs range from \$1,500 to \$2,000 per vehicle, and specially equipped compressor stations are needed to fill the tank. Nevertheless the Department shares the Committee's view that in the near term, CNG would be an attractive option for large fleets.

Action on several fronts is needed if CNG is to realize its potential. First, a regulatory code for CNG storage, handling and use must be completed. This is being done by the Canadian Gas Association in consultation with the provinces and relevant interest groups, and with the encouragement of the Government of Canada.

Second, a program of research, development and demonstration of CNG as a transport fuel should be undertaken. Provinces are involved in such demonstrations through the Federal/Provincial Conservation and Renewable Energy Demonstration Agreements.

Third, an incentives program to promote CNG carburetion is needed, given the higher initial costs facing potential users. The Department has launched a large-scale demonstration program to test the technical and economic feasibility of CNG carburetion delivered through a retail distribution network.

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Electric vehicles

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Electric vehicles may find some acceptance for specialized markets involving short-haul functions but their widespread use is limited, chiefly by the present state of battery technology. Although the Committee showed much interest in the aluminum - air battery currently under development in the United States, the Department feels that support for the commercialization of this battery is not yet justified due to the considerable development that is still required. When the system is sufficiently developed to allow a demonstration of on-board use, its ability to operate in a Canadian climate could then be assessed.

Electric vehicles will have to compete with continuously improving conventional vehicles, and in Canada will also have to prove reliable in an adverse climate. Heat is not a significant byproduct of the electric propulsion unit, so that an auxiliary source for warmth and defrosting would have to be developed and installed. A battery-powered device would also place a substantial energy drain on the propulsion system in winter.

The Committee does not endorse R&D efforts on internal combustion/electric hybrid vehicles; rather it favours the all-electric vehicle. This recommendation seems conjectural, given the early stage of development of both electric and hybrid vehicles. While all-electric systems probably would be more economical for commercial urban vehicles, the situation with private cars is different -- these vehicles are put to widely varying uses.

It will in fact take more than a decade for either all-electric or hybrid vehicles to find their way into the market in significant numbers, and in cars there is a real trade-off in size, weight and range that may make the hybrid more attractive than an all-electric vehicle.

The Electric Vehicle Association of Canada is assessing the domestic market and the potential for establishing an electric vehicle manufacturing industry in Canada.

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CHAPTER THREE ELECTRICITY

Electricity is a highly adaptable form of energy and therefore will play an important role in eliminating Canada's dependence on imported oil. It can serve all regions of the country since it can be produced by a variety of methods -- falling water, nuclear fission, burning of hydrocarbons, and utilizing renewables such as wind, solar and biomass. Electricity is a relatively clean source of energy that can be economically transported over long distances. The Department shares the Committee's outlook that electricity will be a major energy carrier in the future.

Canada has been fortunate to have abundant hydroelectric sites in many regions, low-cost coal for electricity generation in the Prairies and a supply of regional importance in the Atlantic Provinces. Compared to other countries, Canada's dependence on oil and natural gas for producing electricity has been quite small -- about 4 per cent in 1981 -- and is expected to shrink over the next two decades to a lower percentage of total production. Hydro will grow in absolute terms but will shrink as a percentage of total electricity production, while coal and nuclear energy will bear a major burden of growing needs. The Committee shares this outlook.

Under the Canada Oil Substitution Program (COSP), incentives are provided for households to convert space and water heating equipment to electricity -- if produced mainly from non-oil sources -- and to natural gas and renewables. The Utility Off Oil Fund will provide grants for converting existing oil-fuelled utility generation to environmentally acceptable coal-fired stations. Support also is being offered to projects demonstrating new technologies in coal utilization such as fluidized-bed combustion and coal/water mixtures for utility and industrial boilers.

The Lefebvre Report discussed a number of nonconventional sources of electrical power generation. The recommendations, which the Department supports, call for financial and technical assistance to support research, development and demonstration in these areas. Of these alternatives only tidal power is seen as possibly making an important contribution to regional electrical supplies. Ocean power is of marginal interest to Canada while photovoltaics, wind and small-scale hydro are presently best suited to highly specialized applications or as substitutes for diesel-generated electricity in remote communities. Nuclear fusion is a very long-term energy possibility.

- 57, 58 & 64 The Department agrees with the Committee that wave power research rates a low priority within the overall context of energy R&D funding. With respect to photovoltaics however, the Department agrees with the Committee's recommendation that R&D efforts should be expanded and funding has been increased under the NEP.
- 54, 55 & 56 On tidal power development the Lefebvre Report recommends an economic feasibility study be initiated with funding in the order of \$300,000. This is in line with current government programs; a contract was let to a consultant by Nova Scotia Tidal Power Corporation for the Fundy Tidal Power Update, while federal funding of \$275,000 has been made available through the Canada-Nova Scotia Oil Substitution Agreement, with federal participation on the Advisory Committee. The Update, which has now been completed, has provided useful information on the development of Fundy tidal sites as an economically viable source under future supply and market conditions.
- 54, 55 & 56
- 32 & 65 A Remote Community Demonstration program was announced recently; it is expected that a major thrust of this initiative will support the study and demonstration of small-scale hydro generation as an alternative to diesel-generated electricity in isolated communities. A demonstration of small-scale hydro at Roddickton, Newfoundland was recently completed and the resulting report will be available shortly from EMR.
- 32 & 65 This Program will also support wind/diesel hybrid systems. In collaboration with the Province of Ontario, a separate program has funded a wind/diesel hybrid system in northern Ontario. Once this technology has proved reliable and cost-effective in substituting for diesel-generated electricity, more installations will be supported in remote communities throughout Canada.
- 34 The Lefebvre recommendation on fusion R&D is welcome in that it is an attractive long-term energy source that requires a base of high technology. The NRC is proposing a national research facility that would permit a Canadian contribution to a much larger international effort, and involve provincial governments in laying the basis for Canadian industrial development in this field. The Committee's funding recommendation -- \$54 million for the five-year period 1980-81 to 1984-85 -- is only slightly more ambitious than the funding now proposed by the Interdepartmental Panel on Energy R&D and the NRC.
- 34 The Government of Canada has already approved a Tokamak fusion research facility at Varennes, Quebec, at a total cost to the federal government of \$16.6 million over five years. Approval has also been given for a cost-shared

program with the Government of Ontario and Ontario Hydro to develop the materials and materials handling technologies required for fusion reactors (\$600,000 in 1982-83), and for studies in laser-induced fusion. Funding for fusion activities is expected to increase significantly in coming years.

CHAPTER FOUR

HYDROGEN

The Lefebvre Report places major emphasis on hydrogen as a significant feature of Canada's long-term energy future, and strongly recommends that the federal government act now to foster the broad development of an energy system based on hydrogen and electricity. This could entail, as the Committee recognizes, major R&D and demonstration efforts, plus significant industrial expenditures, to solve the production, distribution and usage problems that now deter the development of a hydrogen economy. The fiscal burden, in fact, would not be acceptable to the nation without a significant improvement in the economics of hydrogen.

Nevertheless the importance of hydrogen and the likelihood that its use will greatly increase in the future, as well as the desirability of encouraging the production of hydrogen from electricity, are fully accepted by EMR. In principle, the Lefebvre Report will be adopted as the basis for planning hydrogen-related R&D and demonstration programs, and for support to industry. However, acceptance of the Committee's recommendations is qualified by four concerns: the time frame in which a hydrogen economy could develop; the basic energy source for production of hydrogen; the prospects of a hydrogen production industry emerging without major government intervention; and the extent to which hydrogen could satisfy demand for fuel in the critical transportation sector.

Time frame for the hydrogen economy

38 The Committee clearly regards hydrogen as a fuel for the long term, rather than the present. In its Report, hydrogen is depicted as a transport fuel emerging in the period from 1990 to 2000, and becoming firmly established thereafter. But for both technical and economic reasons, the evidence suggests that hydrogen will not become a major energy currency until roughly the middle of the next century - - perhaps the "very long term", to extend the Committee's terminology. This view is borne out by a number of reviews, notably the recent International Energy Agency study of prospects for electrolytic hydrogen.

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53 An example from the transport sector perhaps will illustrate the point. The most immediate prospect for using hydrogen as a fuel is in long-distance aircraft. As the Committee notes, studies show such aircraft to be economical now. The airline industry is very concerned over availability of jet fuel, which hydrogen could replace. Hydrogen storage and delivery would be

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relatively straightforward in the tightly-controlled and disciplined airport infrastructure. Existing space technology is also most relevant and adaptable to hydrogen. Nonetheless, not even the most optimistic supporter believes demonstration aircraft will be flying before 1990, with commercial use coming after 2000. Clearly, hydrogen as a fuel for ground transport, with greater economic and technical hurdles to overcome, could only be relevant well after 2000.

Primary energy for hydrogen

Canada now uses approximately 10,000 exajoules of energy per year. If hydrogen from electricity were to be a major carrier for this energy -- say for 50 per cent -- the source of the electricity must be considered. About 200 gigawatts of generating capacity would be required to manufacture the hydrogen. Since this is about twice Canada's remaining hydroelectric potential, most of the electricity would have to come from nuclear fission - or from nuclear fusion and solar power, if these energy sources ultimately prove to be technically and economically viable. In any event, there would be formidable economic and logistic problems in the deployment of any electricity generating technology on this scale. There is thus much room for doubt about the viability of hydrogen from electricity as a major feature of Canada's energy economy in the foreseeable future.

Prospects for a hydrogen industry

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The Committee has expressed strong support for developing a hydrogen production and distribution industry in Canada. As it noted, hydrogen is already an important commodity, chiefly in the chemical and petrochemical industries. In fact, about 2 per cent of Canada's primary energy is now converted at some stage into hydrogen within these industries. This already significant demand for hydrogen is expected to grow substantially in the next two decades -- perhaps by a factor of five. Major requirements are forecast in upgrading heavy oils and synthetic crudes, in producing such potential alternative fuels as methanol, and in ammonia manufacture. At the same time, the proportion of hydrogen produced as a byproduct in petroleum refining is expected to diminish greatly.

The projected demands should serve to establish a large-scale hydrogen production industry in Canada, well able to supply not only chemical and petrochemical needs, but also other needs that might arise -- for fuel hydrogen for example. Logically this industry will turn to electrolytically produced hydrogen if and when market economics dictate. This is likely to occur before 2000.

This hydrogen industry will not be the overall hydrogen energy system envisaged by the Committee. It will lack a wide delivery infrastructure since hydrogen will be produced where it is consumed, or at least close to several users. Nevertheless, it would be a significant increase in the energy importance of hydrogen, and it could arise largely from market forces.

Hydrogen as a transport fuel

Canada's need for alternative fuels is most critical in the transportation sector. If hydrogen were to be a central feature of the energy economy, it would have to play a role as a transport fuel. Unfortunately there are major technical and economic problems that deter this use of hydrogen, as the Committee has recognized.

For example, on-board storage of hydrogen is not yet a commercially acceptable technology. Of the two most likely techniques, the Committee suggests that metal hydride storage would be preferable to liquid hydrogen. However, at present neither is economically viable, especially for lighter vehicles that will continue to use the bulk of transportation energy. The Committee believes liquid hydrides will be important in transportation. However, the only hydrides likely to be producible on the scale required -- Canada uses 40 billion litres of gasoline annually -- are those based on fossil fuels. These include gasoline, diesel fuel and methanol. As noted above hydrogen will have a major role to play in producing these fuels, but this will fall short of the hydrogen economy envisaged by the Committee.

It is possible that some of the problems could be solved if special hydrogen "engines" were developed. The fuel cell, using hydrogen to make electricity to power electric motors, is one such engine. Such a system holds the promise of operating at higher efficiencies than conventional engines, thus reducing the volume of hydrogen to be carried. Development of such engines could be important, as the Committee recognizes, but would have to be assessed in the context of a complete hydrogen transportation fuel system.

The preponderance of evidence available, and the concerns cited above, lead EMR to conclude that it would be inappropriate now to launch a major, government-inspired and funded drive to achieve an energy economy based on hydrogen. First, the lead time before the hydrogen era could arrive is still very long, and given our other energy alternatives Canada can afford to proceed cautiously. Second, the major element in a hydrogen economy -- production capability -- should emerge

without significant government involvement. Third, it is still uncertain that the present technological and economic constraints on hydrogen development will ever be satisfactorily resolved. This uncertainty makes it risky to spend very large sums of money now on developing the broad hydrogen systems the Committee recommends, before further information becomes available.

EMR does not accept the need for significantly increased R&D expenditures in hydrogen and related areas. In 1982-83, direct applied research on hydrogen will increase to \$5 million. In addition, considerable basic research will be supported in universities. By 1984-85, EMR expects to recommend expenditures of \$10 million per year on hydrogen R&D and demonstrations. Provincial expenditures and university research grants could double this amount.

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The Department also strongly supports the encouragement of Canada's important electrolyser manufacturing industry. In particular, the Electrolyser Corporation has developed an advanced electrolyser under a 50-50 cost-shared program with the Government of Canada. The demonstration of this technology at commercial scale would boost Canada's industrial capability and advance the date when electrolytic hydrogen could replace hydrogen from fossil fuels. This would be an important step towards the Committee's goal, wherein hydrogen from renewable or inexhaustible sources would play a major role in Canada's energy future.

CHAPTER FIVE
CONCLUSION

This review of the report of the Special Committee on Alternative Energy and Oil Substitution indicates that there is substantial agreement between the views of the Government and the Committee on alternative energy and oil substitution issues. Furthermore, it is evident the Government is already acting on most recommendations of the Committee and in many areas has gone well beyond the actions proposed. Indeed in the areas of alternative energy, oil substitution and energy conservation Canada is emerging as a world leader. This is recognized by the International Energy Agency and the many countries that seek detailed information on Canadian policies, programs and experiences.

Apparent differences between the positions taken by the Committee and the energy policies of the Government arise from the long-term focus of the Committee's work. In developing an overall strategy with respect to energy issues, the Government has had to address a much broader set of problems than those set out in the terms of reference of the Committee. The problem for governments is to address major short and medium-term concerns while at the same time ensuring that long-term issues are not overlooked. In the National Energy Program, considerable attention was paid to the energy objectives that Canada must try to attain within the next decade. These objectives include enhancing domestic nonconventional oil supply, reducing the demand for energy in general and oil in particular, and increasing Canadian ownership of domestic energy resources. The policies that the Government has put in place to attain these near-term objectives have attracted wide attention and therefore have tended to overshadow longer-term concerns.

But despite this reality the Government has taken extensive initiatives to meet long-term energy needs. Indeed, under the National Energy Program there has been a major increase in the government's support for the examination of long-term options, including those favoured by members of the Committee. Currently R&D support for major long-term options such as hydrogen, alcohol fuels, solar energy and very high levels of energy use efficiency, is being significantly expanded. Furthermore, and perhaps more importantly, the links between current patterns of energy supply and use and this array of long-term options are being carefully examined in all energy use sectors and parts of the country. Viewed in this context, there is considerable harmony between the views of the Committee and the concerns of the Government.

One major concern is that over the next 5-15 years our current views on energy alternatives could alter significantly and, as the Committee stressed, we must strive to maintain flexibility in our energy strategy. Although the Government has to make firm decisions to determine our energy course over the next 10-15 years, its overall energy strategy has been to maintain flexibility, particularly with respect to long-term options. This is evident from the significant expansion of the many very promising, if not exciting, energy alternatives now being vigorously investigated by the Government of Canada.

Canada is fortunate in having an enviable array of energy alternatives and the Government firmly believes that the issues raised by the Committee are being creatively addressed under the National Energy Program.

Appendix A

LOCATION OF SPECIFIC RESPONSES TO RECOMMENDATIONS OF THE COMMITTEE

NUMBER	SUBJECT	RECOMMENDATION	PAGE ADDRESSED IN EMR'S RESPONSE
(1)	RD&D	In its own best interest and in the interest of furthering the objectives of the IEA, Canada should accelerate the rate of increase in its alternative energy RD&D expenditures.	8
(2)	Ministry of State	The Committee recommends that a Ministry of State for Alternative Energy and Conservation be created under the Ministry of Energy, Mines and Resources. We further recommend that this new Ministry be divided into four sections responsible for Conservation, Solar Energy, Methanol, and Other Alternatives.	foreword
(3)	Canertech	The Committee recommends that the new alternative energy corporation, Canertech, report to the proposed Minister of State for Alternative Energy and Conservation at the time that it becomes an independent Crown corporation.	foreword
(4)	Energy Economics	The Committee recommends that the Department of Energy, Mines and Resources initiate a comprehensive study of energy and the economy to clarify this important relationship in the Canadian context and to provide guidance in formulating energy policy and more general economic policy.	1
(5)	Conservation	The Committee recommends that a detailed study into all aspects of energy conservation, in all sectors of the economy, be undertaken immediately.	3-4
(6)	Conservation-Passive Solar	All levels of government should cooperate in ensuring that architects, builders and contractors learn and practice energy-efficient design and construction. In particular, these people should be made aware of the energy-saving benefits which result from the passive use of solar energy.	11,14

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| (7) | | The Committee urges that Federally-financed housing incorporate energy-conserving and passive solar design in order to demonstrate its benefits. | 14 |
| (8) | Conservation | Energy performance standards for buildings should be incorporated in the National Building Code so that conservation and innovative design and construction are promoted. | 12-13 |
| (9) | Conservation | Standard tests for the energy performance of buildings should be established by the Federal Government so that energy-efficient ratings can be assigned. | 13 |
| (10) | | The Committee recommends that the Federal Government establish a standard procedure for testing the airtightness of buildings. The Committee further recommends that, once established, the test be applied to Federal Buildings and to all new homes financed through the Canada Mortgage and Housing Corporation. | 13 |
| (11) | | Lighting regimes in businesses and homes should be designed to ensure that electric energy is not wasted. | 14 |
| (12) | | Underground construction should be encouraged in appropriate circumstances as an energy-conserving building technology. | 14 |
| (13) | Ethanol | The Committee recommends that the Federal Government, through Canertech, encourage the research, development and commercialization of cellulose-to-ethanol technology. | 27 |
| (14) | | Ethanol should be used as a gasoline extender only and not as a substitute transportation fuel in pure form, except perhaps on farms. | 27 |
| (15) | | The Committee recommends that the Government ensure, in its amendments to the Excise Act, that production of ethanol in excess of individual requirements may be sold to retail suppliers of alcohol fuel or gasohol. | 27 |

- (16) The Committee does not endorse pure ethanol from starch or sugar feedstocks as a major alternative liquid transportation fuel for Canada. It does, however, recommend that fuel ethanol be permitted for personal use or for the production of gasohol. 27
- (17) Methanol The Committee recommends that the construction of a hybrid natural gas/biomass methanol plant be encouraged to demonstrate this technology of methanol production as soon as possible. 23
- (18) Since hybrid natural gas/biomass methanol plants are a transitional step in establishing a fuel methanol industry, the Committee further recommends that such plants be converted when feasible to operation using biomass alone or biomass spiked with electrolytic hydrogen. 23
- (19) In the short term, Canada should allow fuel methanol to be sold at prices lower than gasoline in order to make it attractive as an alternative transportation fuel. 26
- (20) Biogas The Committee recommends that the technology of anaerobic digestion should be actively pursued in Canada and that additional biogas reactors should be installed to demonstrate their effectiveness in the Canadian environment. 21
- (21) Biomass
Densifi-
cation As the technology for biomass densification is available now and is being used in some locations, the Committee recommends that development of the wood densification industry should be encouraged in Canada. This means that increased emphasis in R&D should be placed on improving combustion technologies for densified biomass fuels and on developing end uses and markets for the densified biomass product. 21
- (22) Wood The Committee recommends that a study of how the increasing combustion of wood in urban areas will affect air quality should begin immediately. Such a study should be completed before expanded use of firewood is recommended for urban centres. 19

- (23) Fire safety regulations should be reviewed and strengthened so that the installation and use of wood stoves and fireplaces does not lead to a tragic increase in the incidence of fires in homes using fuel wood. 19
- (24) Wood-Methanol The Committee believes that the technology of biomass gasification should be funded on a priority basis in biomass R&D. It has the potential of allowing greater use of wood (and other biomass feedstocks) to fire systems which traditionally have used fossil fuels. It is perhaps the last part of the technology of methanol synthesis from biomass which must be improved upon to assure commercialization of this alcohol fuel option. 24
- (25) Peat Canada's extensive peat deposits represent a significant alternative energy opportunity, but our resource base has been only partially outlined. An accurate assessment of its quantity, quality and location should be completed. 24
- (26) The Committee recommends that peat R&D encompass the development of an efficient technology for the gasification of peat. This would allow Canada to broaden its resource base for the production of the alternative liquid transportation fuel methanol. 24
- (27) Fluidized Bed Combustion The Federal Government should undertake a thorough analysis of the opportunities and benefits of fluidized bed combustion in the Canadian context, and of the funding levels necessary to exploit the technology to maximum advantage. Topics which should be addressed in the analysis include the choice between various FBC technologies from economic and environmental standpoints, the use of fuels other than coal, and the nature of regional opportunities. 21,22
- (28) Coal-Oil Mixtures Canadian RD&D in coal-oil mixture technology should be accelerated where feasible. A heavy emphasis should be placed on the rapid deployment of this technology in the Maritime Provinces. 22

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| (29) | Coal
Liquefaction | Coal liquefaction should not be adopted as a long-term energy option for Canada. In the shorter term, however, a limited number of coal liquefaction projects aimed primarily at export markets could be accepted - with stringent environmental safeguards - to earn foreign exchange, to generate skilled employment and technological expertise, and to provide a supplementary source of synthetic fuel for domestic use in an emergency. | 24-25 |
| (30) | District
Heating | The Committee recommends that district heating should be considered as an energy-conserving technology for new subdivisions, communities and industrial parks. | 15 |
| (31) | Co-gener-
ation | The Committee encourages Canadian utilities to look more favourably upon co-generation and to devise means for promoting the broader use of this technology, possibly through joint ownership of such systems with industrial partners. | 17 |
| (32) | Small-
Scale
Hydro | The Committee recommends that financial assistance be extended to isolated communities which rely upon diesel-generated electricity to enable them to install small hydro units where an appropriate site exists. The Committee further recommends that this technology be vigorously promoted for its export potential. | 31 |
| (33) | Fuel
Cells -
Hydrogen | The Committee recommends that research on fuel cells be funded as part of a commitment to developing a hydrogen economy for Canada. In particular, the development of fuel cells for the transportation sector should be given high priority as their use promises to substitute for transportation fuels, to reduce vehicle exhaust emissions and to develop a market for hydrogen. | 35 |

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| (34) | Fusion | The Committee recommends that the Program of expenditures proposed by the NRC Advisory Committee on Fusion-Related Research be adopted by the Federal Government. For the five-year period from fiscal year 1980-81 to 1984-85, this represents an expenditure of approximately \$54 million (in constant 1979 dollars). An independent review should be carried out in the third year of the program and after five years to determine its effectiveness. | 31-32 |
| (35) | Geothermal Energy | The Committee recommends that Federal expenditures on geothermal energy be sufficiently large to accomplish at least the following: to define the size of the geothermal resource in Canada; to promote development of this energy form, especially for space heating; and to determine the feasibility of extracting thermal energy from hot, dry rocks. | 16, 35 43-44 |
| (36) | Heat Pumps | The Committee recommends that heat pump use in suitable community recreation complexes be encouraged and that all three levels of government investigate the potential for financial assistance in this regard. | 14-15 |
| (37) | | Governmental and industrial R&D in Canada should continue to refine heat pump technology. Emphasis should be placed upon penetrating commercial, residential and industrial markets and upon seeking the most effective marrying of heat pumps with other energy technologies. | 14-15 |
| (38) | Hydrogen | The Committee recommends that an energy system based upon hydrogen and electricity as the principal energy currencies be adopted by the Government of Canada as a long-term policy objective. | 33 |
| (39) | | The Committee believes that hydrogen will be an important element of Canada's future energy system and recommends that we begin now to develop the technology and infrastructure for hydrogen production, distribution and use. | 34-35 |

- (40) The Committee agrees that the early demonstration of a hydrogen-based urban transportation system is required in Canada and recommends that research into this use of hydrogen be supported with the aim of rapid commercialization. 35
- (41) The Committee recommends that the Federal Government be prepared to spend up to \$1 billion over the next five years to foster the broad development of a hydrogen-based energy system and to establish Canada as a world leader in hydrogen technology. 35-36
- (42) The Committee recommends that a Commission, to be known as Hydrogen Canada, be established to act as the lead agency for hydrogen RD&D and commercialization in Canada. This Commission should report to the proposed Minister of State for Alternative Energy and Conservation. foreword
- (43) The Committee recommends that the proposed Minister of State for Alternative Energy and Conservation begin a review of the progress and accomplishments of Hydrogen Canada after eighteen months, with the review to be completed within six months. A further review should be conducted after the fourth year of the program, with subsequent reviews to follow at five-year intervals. foreword
- (44) The Committee recommends that the results of the periodic reviews of Hydrogen Canada's progress be tabled in Parliament within three months of their completion and, in the event that Parliament is not sitting at the time, the Minister be permitted to make them public. foreword
- (45) Propane Propane use should be encouraged in the short and medium terms for vehicle fleets refueled at central locations. 27-28
- (46) Compressed Natural Gas The Committee recommends that compressed natural gas be encouraged for use as a fuel in large fleets of vehicles which travel limited distances and are fueled at central filling stations. 28-29

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| (47) | Synthetic Gasoline | Because synthetic gasoline does not reduce hydrocarbon usage and because its production is nonconserving in nature, the Committee recommends that the production of synthetic gasoline from fossil fuel resources should not be viewed as an alternative energy solution of major importance for the transportation sector. | 25-26 |
| (48) | Methanol | To develop a truly alternative vehicle fuel option for consumers, the Committee recommends that the Government of Canada urge automobile manufacturers to produce methanol and dual-fuel engines in Canada. Through this action and the development of a methanol-fuel-producing industry, Canada could become a world leader in methanol production and utilization. | 26 |
| (49) | Ethanol | The Committee recommends that ethanol produced in this country should be used for extending supplies of gasoline through the production of gasohol. We do not recommend the use of ethanol-powered cars as a major alternative transportation option. | 27 |
| (50) | Air-Aluminium Battery | The Committee recommends that the Federal Government closely monitor the development of the aluminum-air battery system and that it support commercialization of this power system in Canada. | 29 |
| (51) | Electric Vehicle | The Committee recommends that Canada become much more actively involved in electric vehicle research, development and demonstration. This effort should be a systems approach which concentrates not only on propulsion but also on the design and construction of all the components required to produce a completely Canadian electric vehicle. | 29 |
| (52) | | The Committee believes that RD&D in this country should concentrate on all-electric vehicles rather than on heat engine/electric hybrids. If hybrid propulsion RD&D is pursued at all, it should be directed towards developing a fuel cell/electric hybrid. This would allow Canada to do research in two areas of nonconventional propulsion simultaneously, so that at some future date each technology could be profitably exploited on its own. | 29 |

(53)	Hydrogen	Canada should pursue the use of hydrogen as an alternative aviation fuel and this activity should form part of the overall RD&D efforts of Hydrogen Canada.	33-34
(54)	Tidal Power	To determine whether a tidal power development in the Bay of Fundy remains a viable proposition, the Committee recommends that an economic feasibility study be initiated without delay to verify the 1977 conclusions of the Tidal Power Review Board, and that funding in the order of \$300,000 be allocated for this purpose.	31
(55)		If the findings of the economic feasibility study are favourable, the Committee further recommends that a three-year pre-investment design engineering, socio-economic and environmental study, as outlined in the 1977 Report, be undertaken and that funding in the order of \$50 million be allocated for this purpose.	31
(56)		If the findings of the definitive study are favourable, the Committee recommends that tidal power development be undertaken in the Bay of Fundy.	31
(57)	Ocean Energy	The Committee believes that Canada should keep up to date with international developments in the field of wave power research and should continue to participate in joint R&D ventures. It also recommends, however, that wave power research should have no priority status in Canadian energy research and development programs.	30-31
(58)		The Committee believes that research and development of OTEC energy should not be funded by the Federal Government at this time.	30-31
(59)	Passive Solar - Conservation	The Federal Government should extend its public education program on conservation to include information on passive solar energy and energy-efficient building practices.	11, 14
(60)	Active Solar	Research should be aimed at reducing the cost and establishing the reliability and durability of thermal storage components in active solar systems.	19

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| (61) | | The funding level for R&D in chemical and large-scale thermal heat storage must be increased substantially and steps must be taken to assist in the commercialization of the systems developed. | 19 |
| (62) | | Consumer incentives for active solar systems should be put in place only when standards have been developed and warranties can be offered. | 20 |
| (63) | | The Committee welcomes the recent announcement of a large-scale demonstration program for solar domestic hot water heating systems and recommends a similar program for active solar space heating systems. This program should incorporate a range of storage systems including zeolite and sodium sulphide. | 20 |
| (64) | Photo-voltaics | In light of both the domestic and export potential for photovoltaic systems, the Committee recommends that Canada's R&D efforts in photovoltaics be accelerated beyond the levels currently planned. | 30-31 |
| (65) | Wind Energy | Funding and technical assistance for installing wind/diesel hybrid systems should be provided to remote communities, with appropriate wind characteristics, now relying on diesel fuel for electrical generation. This assistance would not only help such communities reduce their need for petroleum but would also create an immediate market for wind turbines and hasten the commercialization of this technology. | 31 |

Appendix B

GOVERNMENT OF CANADA CONSERVATION AND OIL- SUBSTITUTION PROGRAMS

Program/Description	Target Sector	Status (as at June 1, 1982)
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ACCELERATED CAPITAL COST ALLOWANCE (ACCA)
- CLASS 34

Offers fast write-offs to certain energy saving, oil displacing and renewable energy utilizing machinery and equipment, in order to encourage business and industry to install those facilities.	commercial industrial	operational
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ARCTIC HOUSING STANDARDS

Develops advanced energy standards to optimize the energy characteristics of new northern housing and ensures the enforcement of these standards in all federally funded housing.	residential	under development
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ATLANTIC ENERGY CONSERVATION INVESTMENT PROGRAM (AECIP)

Provides taxable grants for energy conservation projects proposed by industry, business and private institutions in order to increase energy efficiency and to accelerate conservation in the Atlantic Provinces.	commercial industrial institutional	operational
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BUILDING TECHNOLOGY SUPPORT PROGRAM (BTSP)

Fills R&D gaps and delivers technological know-how to practitioners in building design, construction and operation via engineering research into energy use and conservation in buildings.	buildings	operational
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CANADA OIL SUBSTITUTION PROGRAM (COSP)

Provides taxable contributions toward the costs of converting from oil to alternate energy sources and/or toward the cost of upgrading buildings (residential, commercial, industrial) in order to reduce oil consumption. (See also ECAP)	buildings small business	operational
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CANADIAN HOME INSULATION PROGRAM (CHIP)

Provides taxable grants to householders who retrofit their home in order to improve energy efficiency. All houses built prior to 1971 are eligible for the grant.	residential	operational
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CANERTECH

The function of this Crown corporation is to strengthen the role and competitiveness of Canadian industry in the area of conservation and renewable energy technologies and to stimulate market growth for related products, services and systems by pioneering new and innovative approaches.	all sectors	operational
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COAL CONVERSION PROGRAM

This program is administered by the Canada Centre for Mineral and Energy Technology (CANMET) and has the object of evaluating and supporting research into new coal gasification and liquefaction technologies for the production of economically viable liquid fuels from coal.	all sectors	operational
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COMMERCIAL TASK FORCE PROGRAM

Encourages and stimulates energy management in the commercial subsector by setting conservation targets, preparing audio-visual programs, publications and general information.	commercial	operational
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COMPRESSED NATURAL GAS (CNG) DEMONSTRATION

Encourages, through the provision of contributions, the conversion of gasoline powered vehicles to CNG. The program consists of two subprograms: the 'General Vehicle Demonstration' and a 'Fleet Demonstration'.	transportation	under development
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CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT (CREDA)

Joint funding agreements with provincial governments to develop and demonstrate new technologies which exploit renewables, conserve energy or make its use more efficient.	all sectors	operational
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CONSERVATION RESEARCH AND DEVELOPMENT PROGRAM

Provides technical services and conservation options through R&D activity in order to fill the technological gaps which may be constraining the achievement of increased efficiency. It is an interdepartmental program coordinated by EMR.	all sectors	operational
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ENERGUIDE

An energy labelling program designed to inform consumers of the expected energy consumption of major household appliances. Through improved consumer awareness manufacturers are being motivated to accelerate and extend the introduction of appliance conservation technologies.	residential commercial	operational
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ENER¹¹SAVE¹¹

Fosters energy conservation in the residential sector by: providing a free computerized analysis of a home's insulation requirements; the availability of a toll-free telephone advisory service; and by distributing Fact Sheets which provide detailed information on technical and consumer issues.	residential	operational
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ENHANCED CONSERVATION ASSISTANCE PROGRAM -
RESIDENTIAL SECTOR (ECAP)

Conservation assistance program providing taxable grants for enhanced conservation measures in buildings in Nfld., P.E.I., Yukon and N.W.T. It is a component of the COSP Program. A residential energy audit will be included in ECAP.	buildings	operational
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FEDERAL INTERNAL ENERGY CONSERVATION
PROGRAM (IECP)

Develops and monitors departmental energy conservation targets in order to reduce energy consumption in Federal energy-using activities to at least 10% below that of the 1975-76 level.	federal activities	operational
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FEDERAL INTERNAL OFF-OIL PROGRAM

Encourages federal departments to convert from oil to natural gas and electric heating systems by financing engineering and feasibility studies for potential conversion projects.

federal
buildings

operational

FEDERAL INTERNAL RETROFIT

Provides contributions to federal government institutions for engineering and financial studies of potential retrofit projects to accelerate the upgrading of buildings.

federal
buildings

operational

FEDERAL PROPANE VEHICLE PROGRAM (FPVP)

Funds the conversion or purchase of government vehicles for demonstrating running them on propane; obtains and analyses data on the performance of these vehicles.

transportation

operational

FOREST INDUSTRY RENEWABLE ENERGY PROGRAM (FIRE)

Provides financial incentive to industry and other organizations to utilize biomass as a source of energy. Up to 20% of eligible capital costs are allowed, depending on payback and other criteria.

industrial
commercial
institutional
municipal

operational

INDUSTRIAL ENERGY MANAGEMENT PROGRAM (IEMP)

A two-year cooperative program between the Canadian Manufacturers Association and EMR was initiated in 1978 to promote awareness of the benefits of energy conservation among industrial executives. This program is now being reestablished and expanded.

industrial

under
development

INDUSTRIAL ENERGY CONSERVATION TASK FORCES PROGRAM

A network of 16 industry task forces each having the function of: exchanging information on opportunities for and means of achieving greater energy efficiency; setting and reporting on conservation targets; and serving as a focal point for government/industry discussions on energy conservation.

industrial

operational

MOTOR VEHICLE FUEL CONSUMPTION STANDARDS

Voluntary government/industry vehicle energy conservation program, which sets consumption targets for manufacturers and importers. Beyond 1985 these targets may be made mandatory under the 'Motor Vehicle Fuel Consumption Standards Act' (MVFCSA). Program jointly run by EMR & Transport Canada	transportation	operational
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NATIONAL ENERGY AUDIT PROGRAM (NEAP)

Assists industrial, commercial and institutional organizations to reduce energy demand by providing federal grants, on-site audits, seminars and workshops. This program is a continuation of the Energy Bus Program.	industrial commercial institutional	under development
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NEW LIQUID FUELS RESEARCH AND DEVELOPMENT PROGRAM (NLF R&D)

Intended to develop an integrated, effective national R&D program directed to resolving the technological constraints affecting alternatives to conventional fuels. Program consists of 7 subprograms, whose management is delegated to various federal departments. Program coordinated by EMR.	transportation	operational
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P.E.I. DEMONSTRATION PROGRAM

Demonstrates new technologies which exploit renewable energy resources, conserve energy or enhance efficiency. Intended to help gain market and consumer acceptance of potentially viable technologies.	all sectors	operational
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PROPANE VEHICLE GRANT PROGRAM (PVGP)

Contribution program, offering payments for conversion of commercial and farm vehicles to propane systems or for the purchase of new propane vehicles.	transportation	operational
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PURCHASE AND USE OF SOLAR HEATING (PUSH)

A procurement program under which the Government purchases solar hot water and space heating systems for its own use. PUSH is administered by the Solar Programs Office within Public Works Canada.

federal
government
and Crown
corporation
facilities

operational

QUEBEC DEMONSTRATION PROGRAM

Develops and demonstrates in Quebec new technologies and applications which exploit renewable energy resources, conserve energy or make its use more efficient.

all sectors

under
development

REMOTE COMMUNITIES DEMONSTRATION PROGRAM (RCDP)

Provides financial support to undertake studies for remote community energy planning and for project implementation purposes and promotes awareness of feasible off-oil opportunities available to remote off-grid communities. The first phase consists of a set of planning studies.

remote
communities

under
development

RENEWABLE ENERGY R&D PROGRAM

Provides technology development, technical advice and industry support in the areas of solar, biomass, wind, hydraulic, peat and geothermal energy. This is an interdepartmental program coordinated by NRC.

all sectors

operational

SMALL PROJECTS FUND - BUILDINGS AND URBAN ENERGY

Fosters low-cost initiatives designed to accelerate the implementation of energy conservation opportunities in the area of buildings and urban technology. Currently provides funding support for the 'Building Technology Support' and the 'Commercial Task Forces Program'.

buildings

operational

SMALL PROJECTS FUND - INDUSTRY

Provides direct financial assistance to industry to achieve its energy efficiency goals and finances studies undertaken in cooperation with industry. Provides financial support to commercial task forces programs.

industrial

operational

SMALL PROJECTS FUND - TRANSPORTATION

Establishment of a 'Ridesharing Centre' to promote Vehicle Pooling Concept, Truck Outreach Program, Driver Outreach Program and a marketing study to obtain information on vehicle usage.	transportation	under development
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SOLAR HOT WATER DEMONSTRATION

Assesses the feasibility of solar hot water heating in Canada by providing federal funding, which covers the total cost of each system less \$500 which is the homeowners contribution. System monitoring is required to provide information for future developments.	residential	operational
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SPECIAL ATLANTIC INITIATIVES

Utility Off-Oil Fund

Provides funds for evaluating options leading to the conversion of Coleson Cove electrical generating station from oil to coal.	utility	operational
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Coal Utilization Program

Provides support for introducing new efficient and environmentally acceptable coal utilization technologies. Projects underway include: the construction of the fluidized bed combustion heating plant at CFB, Summerside P.E.I.; the investigation of coal/water slurry combustion technology with the Cape Breton Development Corporation and the New Brunswick Electric Power Commission; the study of coal liquefaction in Cape Breton in cooperation with the Scotia Coal Synfuels Consortia; and the construction of a pilot plant for testing the durability of atmospheric FBC materials in cooperation with the Nova Scotia Power Corporation.	industrial utility	operational
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SUPER-ENERGY-EFFICIENT HOUSING (SEE)

Promotes adoption of super-energy-efficient construction techniques for new homes in the residential sector by providing contributions to builders.	residential	under development
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Appendix C

LIST OF ACRONYMS USED IN THIS REPORT

AECIP	-	Atlantic Energy Conservation Investment Program
BEPI	-	Building Energy Performance Indicator
BTSP	-	Building Technology Support Program
CANMET	-	Canada Centre for Mineral and Energy Technology
CHIP	-	Canadian Home Insulation Program
CMHC	-	Canada Mortgage and Housing Corporation
CNG	-	Compressed Natural Gas
COSP	-	Canada Oil Substitution Program
CREDA	-	Conservation and Renewable Energy Demonstration Agreement
ECAP	-	Enhanced Conservation Assistance Program
EMR	-	Energy, Mines and Resources
ENFOR	-	Energy from the Forest Program
FBC	-	Fluidized Bed Combustion
FIRE	-	Forest Industry Renewable Energy Program
FPVP	-	Federal Propane Vehicle Program
IECP	-	(Federal) Internal Energy Conservation Program
IEMP	-	Industrial Energy Management Program
LEBDA	-	Low Energy Building Design Awards
MEMP	-	Municipal Energy Management Program
MTBE	-	Methyl Tertiary-Butyl Ether
NEAP	-	National Energy Audit Program
NEP	-	National Energy Program
NHA	-	National Housing Act
PUSH	-	Purchase and Use of Solar Heating
PVGP	-	Propane Vehicle Grant Program
RCDP	-	Remote Communities Demonstration Program
R&D	-	Research and Development
SEE	-	Super Energy Efficiency Housing Demonstration Program

